Moving towards independence? Evaluation of the 'Mobility Opportunities Via Education' curriculum with children with profound intellectual and multiple disabilities

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Chapter 2

Movement skill assessment in Children with Profound Multiple Disabilities: a psychometric analysis of the 'Top Down Motor Milestone Test'.

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Abstract

Objective To analyse the psychometric properties of the 'Top Down Motor Milestone Test' (TDMMT)™, an internationally used instrument in the planning and evaluation of movement-oriented interventions.

Setting Centres for special education in the Netherlands.

Subjects Children with profound multiple disabilities.

Methods Validity, reliability and utility of the TDMMT were evaluated. Validity was assessed by conducting a principal component analysis. Reliability was determined by evaluating the internal consistency, test-retest and interrater reliability. With regard to utility, the hierarchical item ordering was evaluated with a Mokken scale analysis. Inter-item and item-rest correlations were calculated to confirm the allocation of the items in the TDMMT.

Results Principal component analysis did not support the presents of three underlying factors. The internal consistency was high and test-retest and interrater reliability varied from moderate to perfect. Scale analysis showed that the subscales of the TDMMT are strong one- dimensional scales with good internal consistency, however, the order of the items could only partly confirmed as well as the allocation of the items into four levels of functioning.

Conclusion The reliability of the TMMT is good, but validity is moderate. Results indicate that adaptations to the structure of the TDMMT should be made when used for children with profound multiple disabilities. Further psychometric evaluation of the TDMMT is necessary.

Keywords Movement skill assessment; Profound multiple disabilities, Movement-oriented activities, 'Top Down Motor Milestone Test'

Introduction

The 'Top Down Motor Milestone Test' (TDMMT)™ assesses movement skills in individuals with severe and profound multiple disabilities and is used by direct support persons in planning and evaluation.[1] The TDMMT forms part of the 'Mobility Opportunities Via Education' (MOVE)™ curriculum, a movement-oriented curriculum to teach functional skills to individuals with multiple disabilities to enhance their independence.[1] Since 1986, the MOVE curriculum as well as the TDMMT have been used worldwide in schools for special education, rehabilitation facilities and centres for individuals with disabilities across the USA, Asia and Europe.[2]

The theoretical basis of the TDMMT and MOVE is based on principles of the psychology of motor learning and functionality. In the functional approach, assessment and training focus on functional skills rather than on impairments and disorders.[3,4] Current educational practices for children and adults with profound multiple disabilities concentrate increasingly on functionality instead of the traditional developmental approach for several reasons. First, children and adults with profound multiple disabilities seem to have both a slow rate of development and a low 'rate of learning': the number of trials or practice sessions needed by a person to learn a new skill. Therefore, training should emphasise the acquisition of essential skills instead of the passing of developmental milestones.[1,2] Furthermore, in children with developmental disabilities, functional skills acquisition often exceeds the demonstrated developmental milestones.[5] Second, the relationship between prevailing impairments and disabilities experienced by the individual in daily life remains unclear. Successful intervention, for instance at a pathophysiological level, will not automatically and positively affect functional limitation or disability.[6] Moreover, with regard to the assumption that training of isolated skills should be transferred to functional activities, the task-specific instruction must take place in the natural environment for retention to occur.[2,7] Third, children with profound multiple disabilities, because of their prevailing disabilities, are totally dependent on their direct support persons in all daily tasks. Therefore, activities offered to children with PMD should be aimed at enhancing their independence and control over their own lives.[8]

Because of this shift towards a functional approach, assessment should also focus on functional skills whereby the degree of independence is emphasized rather than the number of developmental milestones that are mastered. Yet instruments are scarce for children with profound multiple disabilities,[9] especially where functional assessment measures are concerned. Instruments developed to assess functional skills in children with disabilities, such as the 'Paediatric Evaluation Disability Inventory'[10], turn out to be inappropriate for children with profound multiple disabilities.[11] Therefore, research into the TDMMT is worthwhile because of the lack of functional assessments for this specific target group and because of its extensive use in the field of special education and rehabilitation.

In spite of extensive use of the MOVE curriculum and the TDMMT, hardly any data are available on the psychometric properties of the assessment. The MOVE developers only provide implicit information about content validity by describing the development of the items in the TDMMT.[12] Nevertheless, the results of other studies cannot be translated to the psychometric quality of the TDMMT in children with profound multiple disabilities.[13,14] The quality of an instrument has to be reanalysed for each target group and within each context.[15]

The purpose of the current study is to conduct a psychometric analysis of the TDMMT in children with profound multiple disabilities with a special focus on validity, reliability and utility. This should lead to the development of a criterion-referenced instrument to investigate predicted progress due to motor interventions such as the MOVE curriculum.

Method

In total, 66 children with profound multiple disabilities (29 female, 37 male), aged between 2 and 16 years (mean = 8.6 years, standard deviation = 4.1 years) participated in this study. The children were recruited from eight centres for special education throughout the Netherlands. The participants are children with profound multiple disabilities and were selected on the basis of an internationally accepted description.[8] All children had profound intellectual and profound or severe motor disabilities. Some also had sensory impairments and/ or other commonly associated conditions. All children were non-ambulant and required extensive assistance to accomplish everyday tasks. Written informed consent was obtained for all children from their parents. Table 1 presents the predominant diagnoses and disorders as recorded in the medical files of the children.

Table 1 Predominant diagnosis and disorders in the research group

	n
Diagnosis	
Cerebral palsy	32
Syndrome such as Rett's syndrome	17
Microcephaly	4
Chromosome malformations	2
Other	7
Unknown	4
Disorders	
Profound spasticity	37
Hypotonia	13
Visual disorders	23
Auditory disorders	3
Seizure disorders	46
Intestinal disorders	10
Chronic lung problems	8
Problems with food ingestion	9
Behaviour problems	6

Instrument

The TDMMT is a criterion-referenced instrument and is used for instructional planning and progress evaluation.[12] The TDMMT consists of the movement skills sitting, standing and walking that are assumed to be the physical skills required in order to accomplish functional skills, such as expressive language and self-care.[1] Within the TDMMT, three structures can be distinguished: a. 16 movement skills, b. 74 items, and c. four levels of functioning (see also table 2).

a. The movement skills are structured into 16 categories (table 2: A-P). Each category describes one skill that is derived from the movement skills 'sitting', 'standing' and 'walking,' The original skill selection was based on the relationship with functional activities, for instance 'maintaining a sitting position' facilitates communication with the environment, according to the developers.[1]

b. Each movement skill consists of a number of skills referred to as 'motor milestones'[13] or items that form a hierarchical scale. The items are described in quantitative terms with parameters such as the amount of support needed to perform the skill and/or the time or distance that needs to be covered, for example 'can sit on a conventional chair for at least 30 minutes without prompts'. Table 3 describes the items in category A.[16] The parameters are based on the 'functional use of the skill': 30 minutes refers to the time needed to participate in an activity such as eating.[1] In total, the TDMMT consists of 74 items. Each item is marked by the character of the category and a figure (table 2). The format is dichotomous, i.e. the items can be scored either negatively or positively. A

positive score will be given when the child has mastered the particular item. The items within each category form an ordinal scale with the most difficult item at the top.
c. With respect to the third structure that can be distinguished in the TDMMT, the 74 items are sequenced according to four levels of function ('grad level', 'level I', 'level II' and 'level III') (see table 2). These levels form an ordinal scale and describe the amount of 'independent mobility'. A child is functioning independently at 'grad level' and is completely dependent at 'level III'.[1] The child is more independent when he or she needs less support to perform a skill or can cover a longer distance. Table 4 describes the amount of independent mobility at each of the four levels.[1,16]

Table 2 TDMMT: 'Summary of test results'[1,16]

Movement skill/ Category	**Level**												
	Grad			*I*				*II*					*III*
A. Maintains a sitting position				A3	A2	A1		A4	A5	A6			
B. Moves while sitting				B2	B1	B3	B5	B4	B6	B7	B8	B9	B10
C. Stands				C2				C3	C4	C5			
D. Transitions from sitting to standing	D2	D1	D3	D4				D5	D6				
E. Transitions from standing to sitting	E2			E1				E3	E4	E5	E6		
F. Pivots while standing	F1			F2				F3					
G. Walks forward	G1	G2		G3	G4			G5					G6
H. Transitions from standing to walking	H1			H2				H3					
I. Transitions from walking to standing	I1			I2				I3					
J. Walks backward	J1	J2		J3									J4
K. Turns while walking	K1	K2	K3	K4									
L. Walks up steps	L1	L2		L3									
M. Walks down steps	M1	M2	M3										
N. Walks on uneven ground	N1	N2		N3									
O. Walks up slopes	O1			O2	O3								
P. Walks down slopes				P1	P2	P3							

Table 3 Items of category A [1, 16]

		Level			
		Grad	*I*	*II*	*III*
A.1.	Can sit on a flat surface such as a bed or in a bathtub for a minimum of 30 minutes without prompts.	*date*			
A.2.	Can sit on the edge of a bed or on a stool without using a foot or a back rest for a minimum of five minutes.		*date*		
A.3.	Can sit on a conventional classroom chair at least 30 minutes without prompts.		*date*		
A.4.	Can maintain sitting balance on a conventional classroom chair for a minimum of 30 seconds without prompts.			*date*	
A.5.	Can maintain an erect head position for a minimum of 30 seconds while sitting with prompts at the trunk, hips and feet as needed.			*date*	
A.6.	Can tolerate sitting in an upright position for a minimum of 30 minutes with prompts at the trunk, hips, and feet, as needed.			*date*	
A.7.	Can tolerate being placed in a sitting position with a minimum of 90 degrees flexion in the hips and knees.				*date*

Table 4 Levels and description of the amount of independent mobility[1,16]

	Amount of independent mobility
Level	
Grad	Independent mobility in the home, minimal assistance in the community. A wheelchair is not needed.
I	No lifting by the DSP is required. The student can walk with both hands held or with a walker for a minimum of 300 feet. A wheelchair is needed for long distances.
II	The student is able to walk at least 10 feet with help from another person in maintaining balance and shifting weight. A wheelchair will be required for distances of more than 10 feet.
III	The student is totally dependent. Skills at this level will improve bone health and functioning of internal organs and decrease the likelihood of joint deformities and pain.

The TDMMT is administrated retrospectively by a team consisting of the direct support persons (teachers, therapists and parents) of the child who needs to be assessed. First, the first item of category A will be scored (A1). If A1 is scored negatively, A2 will be scored, etc. However, if A1 is scored positively, category B will be assessed; it is assumed that the 'lower' items of category A will also have been mastered. If the rater is not sure whether an item has been mastered, the child can be asked to perform the skill. Second, the positive scoring items are related to the level of function. For instance, mastering item A3 corresponds with the amount of independent mobility described at 'level I'. This means that the child cannot perform the skill completely independently. It is noticeable that in the TDMMT, no composite or summary scores are calculated.[12]

Procedure

To evaluate the test-retest and interrater reliability, the TDMMT was scored by both the physical and occupational therapists of three boys in the research group (aged 6, 11 and 13 years). The therapists work with the TDMMT for years and were trained by a qualified 'MOVE international trainer'.[16] The knowledge of the child on the part of both therapists was assumed to be equal to prevent bias in the reliability.[12] Both therapists scored the 'normal' form of the TDMMT two times with two weeks between the measurements. To prevent bias, the therapists were blinded for the scores of the first measurement and for the scores of each other.

In all other analyses, the TDMMT scores of all the participating children were used. Each TDMMT was scored by a team consisting of the direct support persons (teachers, therapists and parents) of the child whereby all items were scored, including the items that are usually considered to be redundant. These scores were used to evaluate whether the ordering of the items, based on

their difficulty, could be confirmed. This alteration to the original procedure of the TDMMT was explained to the direct support persons.

Analyses

The percentage of positively scored items were calculated for each category. To assess validity, a principal component analysis with varimax rotation was conducted.[17] Three factors, assumed to represents the three clusters of movement skills 'sitting', 'standing' and 'walking', the movement skills that are supposed to be the essentials skills for the acquisition of all motor and functional skills[1] were distinguished. The internal consistency of the categories, which serves as a criterion for the reliability, was determined by calculating Cronbach's Alpha. A Cronbach's Alpha between .70 and .90 signifies a good internal consistency.[18] The 'corrected item total correlation' was calculated to determine the influence of each movement skill on the total internal consistency. The test-retest and interrater reliability were determined by calculating Cohen's Kappa.[18]

The utility of the TDMMT was evaluated by two analyses. First, the hierarchical item ordering of each of the 16 categories was evaluated using a Mokken scale analysis. This analysis is derived from the item response theory and can be seen as a probabilistic version of Guttman's scalogram analysis.[19-21] The Mokken scale analysis is extensively used in medical, social and psychological studies.[22-24] The 'fit' of each item within the scale was calculated by the coefficient 'H-item,' which should be at least .30. The scalability coefficient 'H' was calculated for each scales and must exceeds .50 to form a 'strong scale'. The internal consistency of each scale was calculated by Rho, whereby Rho exceeding .70 is a minimum requirement.[22-24] The second analysis with regard to the utility is the confirmation of the allocation of the items into the four levels. Therefore, the correlation and item-rest correlation between the item score and total score of the four levels was calculated using Pearson's product–moment correlation coefficient. Items should be correlate at least .20 with the total score and should be allocated to the highest correlating level.[18]

Results

Validity

When three factors were extracted, 83% of the total variance could be explained. Factor one explained 71%, factor two 8% and factor three 5% of the total variance. The categories A-E, H and I load at factor one, the categories F, K -P at factor two and only category J loaded at the third factor. Category G loaded high for factor one as well as for factor two. However, only two factors had an 'Eigenvalue' greater than 1 and the 'scree plot' only supported one factor. Further analysis showed that, when two factors were extracted, categories A to E and G to I loaded at factor one and the other categories (F and J to P) loaded at factor two.

Reliability

Crohnbach's alpha of the categories was .95. The item-rest correlations varied between .54 (category M) and .90 (category G), with the mean .80. Omitting one of the movement skills did not change the homogeneity of the TDMMT significantly. The largest changes occurred by omitting category B, which resulted in an increase of alpha to .96 and omitting category G, which resulted in an alpha of .94.

Cohens's Kappa of rater A was 1.0 for all categories except B, E and J. Cohens's Kappa for these categories was .58, .64 and .61, respectively. For rater B, Cohens's Kappa was 1.0 for all

categories. The interrater reliability varied from .58 to 1.0 (mean .97) at the first measurement and .61 to 1.0 (mean .95) at the second measurement.

Utility

Table 5 presents the results of the Mokken scale analysis. The 'H-items' of the categories H, I, L and M could not be calculated because all children scored the highest items negatively. The remaining H-items varied from .46 to 1.0 (mean .94). Scale coefficient H varied from .86 to 1.0 (mean .97) and Rho varied from .76 to 1.0 (mean .88). Within each scale, the items had a different 'index of difficulty', except categories 'M' and 'P'. The order of the items in each scale, based on the index of difficulty, is presented in table 5.

Table 5 Results of the Mokken scale analysis

Skill	H-value	Rho	Optimal sequence of items[1]
A	.91	.92	3,2,1,4,5,6,7
B	.94	.95	2,1,3,5,4,6,7,8,9,10,11
C	.86	.77	1,2,3,4,5,6
D	1.00	.93	2,1,3,4,5,6
E	.98	.90	2,1,3,4,5,6
F	1.00	.90	1,2,3
G	.96	.87	1,2,3,4,5,6
H	1.00	.80	[2]1,2,3
I	1.00	.84	[2]1,2,3
J	.89	.76	1,2,3,4
K	1.00	.89	1,2,3,4
L	1.00	.86	[2]1,2,3
M	1.00	1.00	[2]1,2/3[3]
N	1.00	.88	1,2,3
O	1.00	.89	1,2,3
P	1.00	.98	[3]1/2,3

[1]based on the index of difficulty

[2]the first items of these categories were excluded from the analysis because all children scored those negative.

[3] items with the same ´index of difficulty´

Analysis of the allocation of the items within the four levels of function showed that four items at `ad level` correlated .00 with the total score at grad level because all children scored these items negatively. Item C1 did not correlate above .20 with one of the levels. The remaining items of 'grad level' correlated significantly with this level. However, five items correlated more strongly with `level I`. With regard to 'level I', although all items correlated significantly with this level, ten of the items correlated more strongly with another level; six more strongly with 'grad level' and four more strongly with 'level II'. With regard to the items in 'level II', all items correlated significantly with this level. Nevertheless, one item of 'level II' correlated more strongly with 'level III', six items correlated more strongly with 'level I' and one item with 'grad level'. Of the six items in 'level III', only two items correlated significantly with this level. One item had a stronger correlation with 'level II'. However, the remaining items in 'level III' did not correlate significantly with any of the four levels.

Discussion

The current study analysed validity, reliability and utility as part of the psychometric properties of the TDMMT in children with profound multiple disabilities.

With respect to the validity, factor analysis did not confirm the assumption of three underlying factors that describe the movement skills of sitting, standing and walking. Dependent of the use of the 'Kaiser criterion' or based at the 'scree plot', the 16 movement skills could be best explained by only one or two underlying factors.[17]
With regard to the reliability, results showed a good internal consistency between the 16 categories of the TDMMT. However, this internal consistency was so high that some of the categories can probably be assumed to be 'redundant'[18] ;omitting one of the categories yielded the same results. This is consistent with the results of the analyses if the validity. The test-retest reliability varied from moderate to perfect and can be considered as satisfactory. On average, the interrater reliability was strong.
Scale analysis indicated a hierarchical and one-dimensional structure for the 16 subscales of the TDMMT. This enhances construct validity and it indicates the presence of an one-dimensional theoretical construct. This could be the amount of independence in performing movement skills. The TDMMT is developed within a framework that emphasises the individual's independence. The implicit norm, operationalized in the levels of function, also refers to the amount of independence. In addition, the items are described in terms of the amount of support necessary to perform a skill and systematic reduction of the number of prompts is one of the critical components of the MOVE curriculum.[1,2] However, the fact that a scale can be constructed with good psychometric qualities is not sufficient reason for concluding that the underlying theory is valid. Reliability of the 16 subscales was satisfactory and the scales can be said to be strong. The order of the items, however, differed from the TDMMT. Also, the allocation of the items into the levels could not be completely confirmed. Four items did not correlate highly enough with one of the levels and 22 items correlated significantly less with their 'own level' than another level. Allocation to this level is justified.[18]

Results of the current study show that the psychometric properties of the TDMMT in children with profound multiple disabilities are only partially sufficient. These results are predominantly in accordance with the findings of other studies into the psychometric properties of the TDMMT. Elkins,[13] who conducted a study into the effects of the MOVE curriculum, found a good test-retest reliability of the instrument in individuals with severe multiple disabilities. She also claims a good content validity, however without referring to research into the utility and efficiency of the TDMMT. Brach and colleges[14] found high test-retest and interrater reliability but moderate external validity in an adapted version of the TDMMT for the aged.
In compliance with the domain of psychometric analyses, in general the quality of the TDMMT in children with profound multiple disabilities is hard to establish. First, it is difficult to find a research group that is sufficiently large. In the current study, sample size seems to be rather small. In the Netherlands, however, there are only 91 centres for special education with approximately 1350 children with profound multiple disabilities aged between 0 and 18 years.[25] The participants can be considered to be representative for the total group of children with profound multiple disabilities who attend a centre for special education because the children were selected using an internationally accepted description[8] and the centres are also comparable to others.[26] Further research must be conducted before the results can be generalized to other settings, such as institutions, and other groups, such as adults or individuals with less severe disabilities. Second, research into psychometric quality of the TDMMT is difficult because of the retrospective administration of it by a person who knows the child well. The agreement between raters can only be properly established if the knowledge of the raters is equal with precludes using unbiased independent raters. This explained also the extraordinarily small number of children for studying the test- retest and inter rater reliability in the current study. It is also nearly impossible to determine intrarater reliability because 'the exact same administration just cannot be repeated'.[12] The agreement between therapists, support persons and parents, however, can be an appropriate

strategy to provide more evidence for the reliability of the TDMMT.[12] Third, research into criterion-related evidence is not possible because of the lack of an instrument that can be compared to the TDMMT. Research into 'content-related evidence', on the other hand, can be conducted, whereby a panel of judges evaluate the TDMMT in which the items are evaluated based on specific criteria concerning relevance and accuracy.[15]

This study provides clinically and scientifically relevant information concerning the TDMMT in children with profound multiple disabilities. For practical reasons, the time required to administer a test should be as limited as possible.[24] The TDMMT meets the requirements of a Gutmann scale. This means that the score of the child can be assessed by applying only a few items. However, the results presented suggest that adaptations to the structure of the TDMMT are needed where children with profound multiple disabilities are concerned. The order of the items in categories A, B, D and E should be changed, based on the 'indices of difficulty'. Furthermore, items M2 and P2 should be removed. These choices are based on theoretical considerations. Item M2 is not described in terms of concrete skills, which is not in accordance with the concept of functionality.[27-29] In category P, the item with less prompt (P1) should be retained because both the TDMMT and the MOVE curriculum aim at systematic prompt reduction. Items A7, B11, C1 and C6 should be removed because of the low correlation with one of the four levels. The remaining items should be allocated to the level with the strongest correlation. Table 6 presents the adjusted version of the TDMMT for children with profound multiple disabilities, based on the results of the current study.

Table 6 Adjusted TDMMT based on the presented results

	Level												
Category	*Grad*			*I*				*II*					*III*
A				A3	A2	A1		A4	A5	A6			
B				B2	B1	B3	B5	B4	B6	B7	B8	B9	B10
C				C2				C3	C4	C5			
D	D2	D1	D3	D4				D5	D6				
E	E2			E1				E3	E4	E5	E6		
F	F1			F2				F3					
G	G1	G2		G3	G4			G5					G6
H	H1			H2				H3					
I	I1			I2				I3					
J	J1	J2		J3									J4
K	K1	K2	K3	K4									
L	L1	L2		L3									
M	M1	M2	M3										
N	N1	N2		N3									
O	O1			O2	O3								
P				P1	P2	P3							

Functional measures provide useful information for the determination of treatment goals and planning.[30] In the treatment planning, however, it is possible that an incorrect estimation of the (partial) skill to be practiced 'next' will be made on the basis of the current version of the TDMMT with children with profound multiple disabilities. The suggested changes also have implications for treatment evaluation. In treatment evaluation, the ability of the child may be wrongly assessed. When actually using the TDMMT for children with profound multiple disabilities , it is important to note these changes so that a correct interpretation of test scores can be achieved.[15]

This research has contributed to the development of an instrument to chart the motor functioning of children with profound multiple disabilities. Specifically, it is an instrument directed towards determining motor functioning in a functional perspective, not previously attested for this group. Even without the MOVE curriculum, the TDMMT can be used to evaluate movement interventions and the effects on the functional domain. In addition, the current research has provided fundamental insight into the motor functioning of children with profound multiple disabilities, and the way they master motor skills.

Clinical messages

- The TDMMT could be markedly shortened which benefits assessment time and utility.
- The TDMMT is a potential useful assessment instrument for children with profound multiple disabilities. This is important, as assessment instruments that are specifically designed for this target group, are scarce.
- The TDMMT can be used to evaluate functionally focussed motor training for children with profound multiple disabilities.

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